Eating and Drinking in Space

Or The Case of the Floating Peanut!

Grades: 5-8

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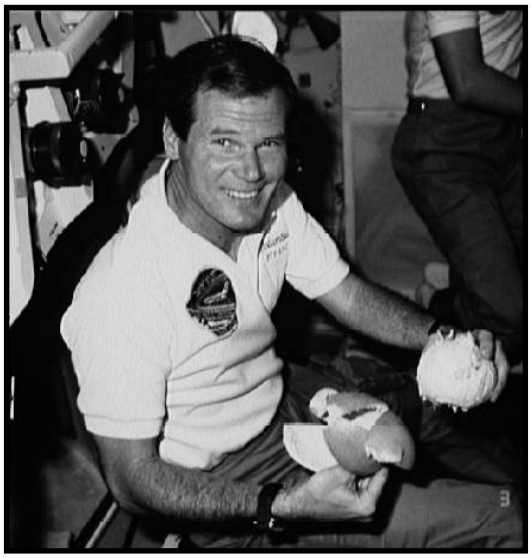
Overview

Living in space means many changes to our daily routine. Even simple activities, like eating and drinking, must be carefully planned to prevent serious problems aboard a spacecraft.

Astronaut Anthony W. England, mission specialist, drinks a Coke while floating in the shuttle.

Water, for instance, behaves quite differently in the **microgravity** of space than it does on Earth. Here on Earth, we drink a glass of water by tilting the glass and letting water flow down our throats—sometimes a little may even dribble down our chins. The remaining water in the glass sloshes around and maybe splashes a bit, but most of it will return into the glass. In microgravity, we can turn that same glass upside-down and not a single drop of water leaves the glass. Trying to drink a glass of water is different also: when we tip the glass, water will pour over the rim of the glass, break up into little balls of water, and float away. These floating balls of water can damage delicate instruments and equipment, and may even ruin experiments being performed. Clearly, astronauts need special types of drink in space!

Eating solid foods in space can cause more problems. One of the most important laws in physics states that for every action, there is an equal and opposite reaction. This law applies to all actions, even the simple act of cutting a steak. The force you apply with your knife to cut the steak can cause just enough force to push you away from your plate. Foods that produce crumbs, like cookies and crackers, are just as troublesome, since they float around the cabin. They can be hazardous to instrumentation or even get in a crewmember's eye. As a result of the special challenges to eating and drinking in microgravity, food is carefully selected not only with nutrition and taste in mind, but also with preparation, packaging, and storability as factors for consideration.



Astronaut Bill Nelson, payload specialist, prepares to eat a fresh grapefruit.

Foods to be consumed during a Shuttle mission are selected through a careful and lengthy process. Eight to nine months before a flight, astronauts sample wide variety of foods and beverages. They also receive an information pack containing a standard menu, a training menu, past flight menus, and the baseline Space Shuttle food and beverage list. Five months before the flight, astronauts submit their choices for individual menus. The Space Shuttle dietitian then analyzes the menus for nutritional content. If the astronauts' menus are missing foods that would provide important vitamins and minerals, the dietitian suggests menu changes to ensure that astronauts receive the nutrition they need to remain healthy.

Objective

The intent of this lesson is to teach good nutrition habits, and thereby increase the level of awareness.

Key Questions

- Why is good nutrition important?
- Why do dietitians need to analyze the nutritional value of food for space flight?

Time Frame

Preparation: 30 minutes
Activity: 1 class period

Materials

- pencil and paper
- "Baseline Shuttle Food List"
- Food Pyramid
- calculator
- For home assignment, students will need aluminum foil, plastic wrap, and art supplies (construction paper, crayons, scissors, glue, tape, etc.) at a minimum.

Getting Ready

1. Read "Background for Teachers" section near the end of this activity
2. Read Pre-Activity Discussion
3. Copy "Baseline Shuttle Food List" for each student
4. Make transparency of "Typical Shuttle Menu Selection"
5. Make transparency of the Food Pyramid
6. Copy Food Pyramid for each student

The Space Shuttle food tray holds packets of dehydrated food and a beverage.

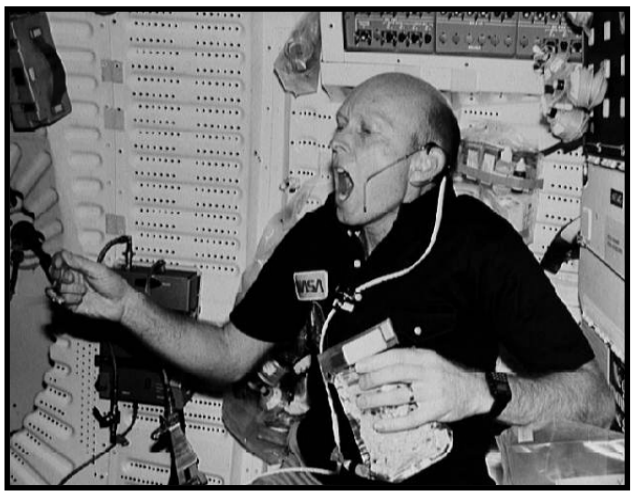
Classroom Activity

Pre-Activity Discussion

1. Shuttle Food – Each person on the shuttle is allotted 3.8 pounds of food per day, which includes 1 pound of packaging weight. No refrigeration is necessary because foods are precooked or processed and individually wrapped. The food is either ready to eat or can be easily prepared by adding water and heating as needed. Fresh fruit and vegetables are the only exceptions, since they must be eaten within the first two days of flight to avoid spoiling.

There are seven classifications for Space Shuttle food:

a) **Rehydratable Food**: Because on-board weight must be kept to a minimum during space flight, weight is conserved by removing the water from foods and beverages. Rehydratable food and beverages are stored in thick plastic or foil pouches with an attachment for adding water. Water is added back to the foods and beverages just before eating and drinking. Foods packaged in rehydratable containers include soups, casseroles, appetizers, and breakfast foods.



Pilot Fullerton awaits the arrival of a free-floating spoonful of food.

b) **Thermostabilized Food**: Heat processing, called thermostabilization, is used to destroy harmful enzymes and microorganisms in foods. Thermostabilized foods, such as fruits and fish, are packaged in cans with easy-open, full-panel, pullout lids. Most of the entrees are packaged in flexible retort packages. The packages are heated, cut open with scissors, and eaten

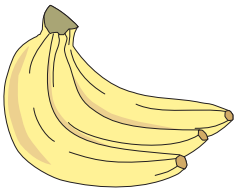
directly from the containers with normal knives, forks, and spoons. Individual servings, like pudding, are available on grocery store shelves.

c) **Intermediate Moisture Foods**: Intermediate moisture foods are preserved by restricting the amount of water available for microbial growth, while retaining just enough water (usually 15-30 percent) to give the food a soft texture so that it can be eaten without additional preparation. Water is removed, or its activity restricted, with a water-binding substance like sugar or salt. Intermediate Moisture Foods are packaged in clear, flexible packages that are cut open with scissors. Examples of intermediate moisture foods include dried fruits (peaches, apricots, and pears) and dried beef.

d) **Natural Form Foods**: Some foods come packaged in their natural state, and need no further preparation. Both intermediate moisture and natural form foods are packaged in flexible pouches and are ready to eat. Brownies, nuts, and cookies are good examples of natural form foods.

Commander Loren J. Shriver, pursues several floating chocolate-covered peanut candies

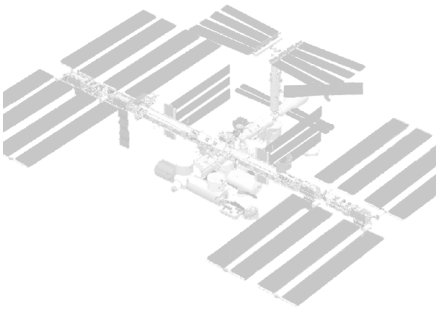
e) **Irradiated Meat**: Beef steak and smoked turkey are the only irradiated products currently used on the Space Shuttle. The meat is cooked before launch, and packaged in flexible, foil-laminated pouches. The meat is then exposed to ionizing radiation. Because radiation will kill any harmful bacteria, the food is safe to eat at room temperature.



f) **Condiments**: Commercially packaged, individual pouches of mustard, taco sauce, catsup, mayonnaise, and hot pepper sauce are used for condiments. Because regular salt and pepper would not stay on food, but would instead float around the Shuttle cabin, salt is dissolved in water and pepper is suspended in oil. Plastic dropper bottles are used to hold liquid salt and pepper.

g) **Shelf Stable Tortillas**: Shelf stable tortillas were developed for use on Space Shuttle missions of extended length because mold presents a problem with commercially packaged tortillas. Stabilization is accomplished through a complex process that takes into account atmosphere content, the acidity of the food, and the water content in the food. Removing oxygen from the package inhibits mold growth.

2. Station Food - For the International Space Station (ISS), menus will be based on everyday eating habits, nutritional content, and utility in space. The daily menu will include frozen,

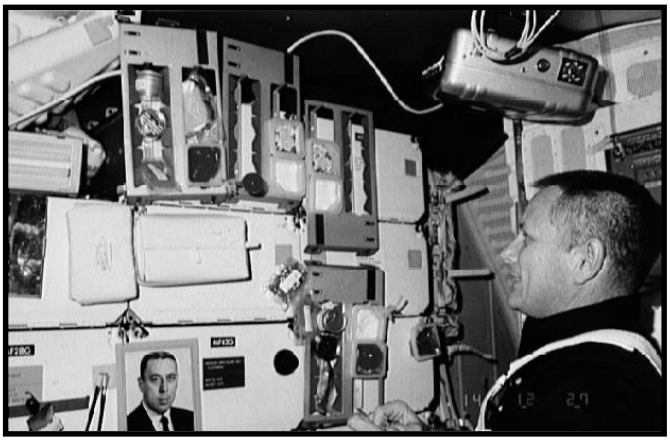


Astronaut Rhea Seddon "sits" down to a meal.

refrigerated, and ambient-temperature foods. Most entrees, vegetables, and dessert items will be frozen. Fresh and fresh-treated fruits and vegetables, extended shelf life refrigerated foods, and dairy products will require refrigeration. Ambient foods will include thermostabilized, shelf-stable natural form foods, and rehydratable beverages. The packaging system is based on single-serve, disposable containers. Not only does this make menu changes easy, but it also eliminates the need for a dishwasher. Food packaging engineers have developed a "system" in which all packages have the same width. All packages can then be easily stored, anchored to the table, or secured in the oven.

3. **Meal Preparation** – Food is prepared in a galley on the Space Shuttle's mid-deck. The galley contains a hot and cold water dispenser for food rehydration and an oven for heating foods. Both hot and cold water can be dispensed in one-half ounce increments to a maximum of eight ounces, which would fill a can of soda. The oven heats food and beverages in two ways. The **conduction** method uses a hot plate to physically transfer heat from the plate to the food. The **convection** method circulates heated air throughout the oven to heat food. It is spacious enough to hold 14 rehydratable packages, plus several additional thermostabilized pouches and beverages.

4. **Eating and Drinking in Space** - The dishes and glassware that we use on Earth are not very useful in space. Instead, all meals are eaten on a food tray, which is compartmentalized to hold different containers. The bottom of each food container, as well as each section on the food tray, has Velcro strips or dots to prevent the food container from floating away. The bottom of the food tray itself has Velcro that attaches to the leg of the astronaut's jumpsuit or to a wall. Although conventional knives, forks, and spoons are used in space, a pair of scissors is included as an essential dining utensil. The scissors are necessary to cut open the packages of food.



Pilot Overmyer, uses a beverage container and drinking straw secured in meal tray assembly.

Foil laminate is used to package beverages. The foil pouches ensure a longer

product shelf life. After the beverage powder has been added to the pouch, a "septum adapter" is sealed in the package. This device contains a sealed tube that connects to the galley water dispenser for reconstituting, and a straw for drinking the liquid.

While there are no dishes to wash, utensils and food trays are cleaned with pre-moistened towelettes and stowed away for the next meal. Empty food packages are placed in plastic bags that are stowed in the trash compartment located below the mid-deck floor.

Eating and Drinking in Space Activity

Instruct your students in the following steps of the activity procedure:

1. Challenge the students to think of dehydrated, thermostabilized, intermediate moisture, and natural form foods and beverages that they eat and drink. On the board, make a list of the suggested foods. Discuss which foods can be easily stored and which must be eaten immediately.
2. Ask the students which of those listed foods may be more nutritious than others and why. Show the transparency of the Food Pyramid, and discuss where each of the listed foods would fit.
3. Divide the students in groups of two or more and hand each group the Baseline Shuttle Food and Beverage List and the Food Pyramid. Explain to the students that the letter in parenthesis designates the classification for that food and the number is the weight of the food (without packaging) in grams. (Note the conversion factor at the bottom of the Baseline Shuttle Food and Beverage List)
4. Have each group design a nutritionally balanced menu for one astronaut during a ten-day mission (length can be shortened or extended). Students should refer to the Food Pyramid as a guideline for daily nutritional needs, and must ensure that the menu does not require more than 2.8 pounds of food per day. Remind the students to consider nutritional value, taste, and weight as they design their menus.
5. Have each group select a member to list on the board their menu for one day (breakfast, lunch, and dinner). They must also list and sum the weight of each food item to be certain that they stay within the daily allotment.

Wrap-up Session

1. Have a class discussion about the nutritional value of each listed menu.
2. Share with the class the "Typical Shuttle Menu Selection".

More Activity Ideas

Have the students check the following Internet sites for more information on food technology and advanced life support systems:

http://www.jsc.nasa.gov/pao/factsheets/nasapubs/food.html
Food For Space Flight

http://www.ccacademy.pvt.k12.ma.us/grade05/rendezvous/food.html
Eating in Space (By Leone)

http://www.jsc.nasa.gov/sa/sd/facility/wafalde.htm
Water and Food Analytical Laboratory

http://pet.jsc.nasa.gov
Food Technology and Nutrition

http://quest.arc.nasa.gov/smore/question/new/Eating_Space_Grown_Plants.txt
Eating Space Grown Plants

Http://www.eatright.org/nuresources.html
Nutrition Resources for Consumers

Extension Activities

Homework: Have the students design a 28-day flight menu for one astronaut on the International Space Station. (You may want to give them a couple of days for completion)

Homework: Each student will package and label the items from one of their group's meals. (The students are not expected to waste good food or have access to many of the dehydrated foodstuffs. This will be a chance to show their creative skills and artistic ability.) The next day, they will explain the contents, where they fall on the Food Pyramid, and the packaging of their meal to the class.

Background for Teachers

Prerequisites:

Students should be able to:

- use simple reasoning and deduction
- record data

- convert from metric to standard

Vocabulary:

- **condimen**t - a seasoning for food, such as mustard or various spices
- **irradiate** - to treat with radiation
- **rehydrate** - to add back the water that was removed
- **thermostable -** unaffected by relatively high temperatures
- **conduction** - the transmission of electric charge or heat through a conducting medium without perceptible motion of the medium itself
- **convection** - heat transfer in a gas or liquid by the circulation of currents from one region to another
- **microgravity** – the existence of the very small force of gravity that exists in the "weightlessness" of space

Skills/Science Standards

- personal health
- think critically and logically to make the relationships between evidence and explanations.
- communicate scientific procedures and explanations.

Concept: the importance of good nutrition